IMPROVE PERMITTING EFFICIENCY

FIRST ANNUAL UIC CLASS

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First Annual UIC Class
June 12, 2012

Agenda

- Overview of UIC program
- Applicable regulations
- Underground Injection Control (UIC) application process
- Seismic issues
- Hydrologic consultation
- Operator's timeline
- Proposed hydrofracturing with diesel regulations

Federal Regulations Basis and Defining UIC

- 40 CFR 144 – Underground Injection Control Program
- 40 CFR 145 – State UIC Program Requirements
- 40 CFR 146 – Underground Injection Control Program: Criteria and Standards
- 40 CFR 147 – State, Tribal, and EPA-Administered Underground Injection Control Programs
  - Subpart G - Colorado

Classes of Injection Wells

- All underground injection wells are regulated by the Safe Drinking Water Act
  - Class I: wells used to inject hazardous waste or industrial waste below a USDW
  - Class II: wells used to dispose of oil or gas production fluids or wells used for enhanced recovery
  - Class III: wells used for solution mining
  - Class IV: wells used to inject hazardous waste or industrial waste above a USDW (banned except for those which are part of an EPA or state approved CERCLA or RCRA project)
  - Class V: all others or wells used to inject nonhazardous fluid into a USDW
  - Class VI: wells used to inject carbon dioxide into the ground for sequestration

Applicable Regulations
40 CFR 144 through 147

- UIC program is part of the Safe Drinking Water Act administered by the Environmental Protection Agency (EPA)
- Colorado was given primacy for Class II injection wells in 1984
- Injection wells within Indian reservation boundaries in Colorado are regulated by EPA

State Primacy

- The EPA often delegates regulation of UIC wells to individual states (primacy)
- The EPA delegates regulation of other classes of wells to individual states (e.g., Wyoming has primacy over other classes of wells)
- Colorado has primacy over Class II wells since April 2, 1984
- EPA does not engage with the routine operations of state operation

Definition of Class II Waste

Resource Conservation and Recovery Act (RCRA) Subpart C Exempt Waste

Because the RCRA exempt status of an oilfield waste is based on the relationship of the waste to exploration and production (E&P) operations, and not on the chemical nature of the waste, it is possible for an exempt waste and a non-exempt hazardous waste to be chemically very similar.

Allowable Injection Fluids

What comes out of a well

- Produced water
- Drilling fluids
- *Spent* well treatment or stimulation fluids
- Pigging wastes
- Gas plant wastes
  - Amine
  - Cooling tower blowdown
  - Tank bottoms

Non-allowable Fluids

What did not go into a well

- Unused fracturing fluids or acids
- Painting wastes
- Refinery wastes
- Lubricating oils
- Sanitary wastes
- Radioactive tracer wastes

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Applicable Regulations

- Rule 324b addresses aquifer exemptions
- Rule 325 addresses underground disposal of water
- 400 Series Rules address enhanced recovery operations because fluids are injected

Applicable Regulations
Aquifer Exemptions

- Rule 324b addresses aquifer exemptions
  - Testing of water quality of disposal formation is required. If total dissolved solids (TDS) < 10,000 ppm, an aquifer exemption is required.
  - Aquifer exemptions are granted when:
    - The formation is hydrocarbon producing
    - The formation is too deep to be economically produced as a source of drinking water
    - The water is so contaminated it would be economically impractical to treat it for human consumption
  - Notice of the aquifer exemption request is published in the local newspaper for a 30-day comment period
  - The notice is also forwarded to the EPA and Colorado Department of Public Health and Environment for their review

Applicable Regulations Underground Disposal

- Rule 325 addresses underground disposal of water
  - Notice to surface owners and mineral owners within ¼ mile – this is not the same things as “mineral rights”; owner’s permission is required
  - Publication of disposal well notice in local newspaper announcing a 30-day comment period
  - Various well bore construction information
  - Testing for water quality of disposal formation. If TDS < 10,000 ppm, an aquifer exemption is required.
- For enhanced recovery operations, these steps are done over the entire unit area

Applicable Regulations Enhanced Recovery

- 400 Series Regulations
  - Prohibits enhanced recovery operations, cycling or recycling operations including the extraction and separation of liquid hydrocarbons from natural gas in connection therewith, or operations for the storage of gaseous or liquid hydrocarbons, nor carrying on any other method of unit or cooperative development or operation of a filed or a part of either, without having first obtained written authorization from the Commission to perform the aforementioned activities or operations.

Enhanced Recovery

- Injection into the same formation production is taking place is enhanced recovery or water cycling.
- Unitization of field is necessary in order to protect correlative rights.

TYPICAL INJECTION WELL

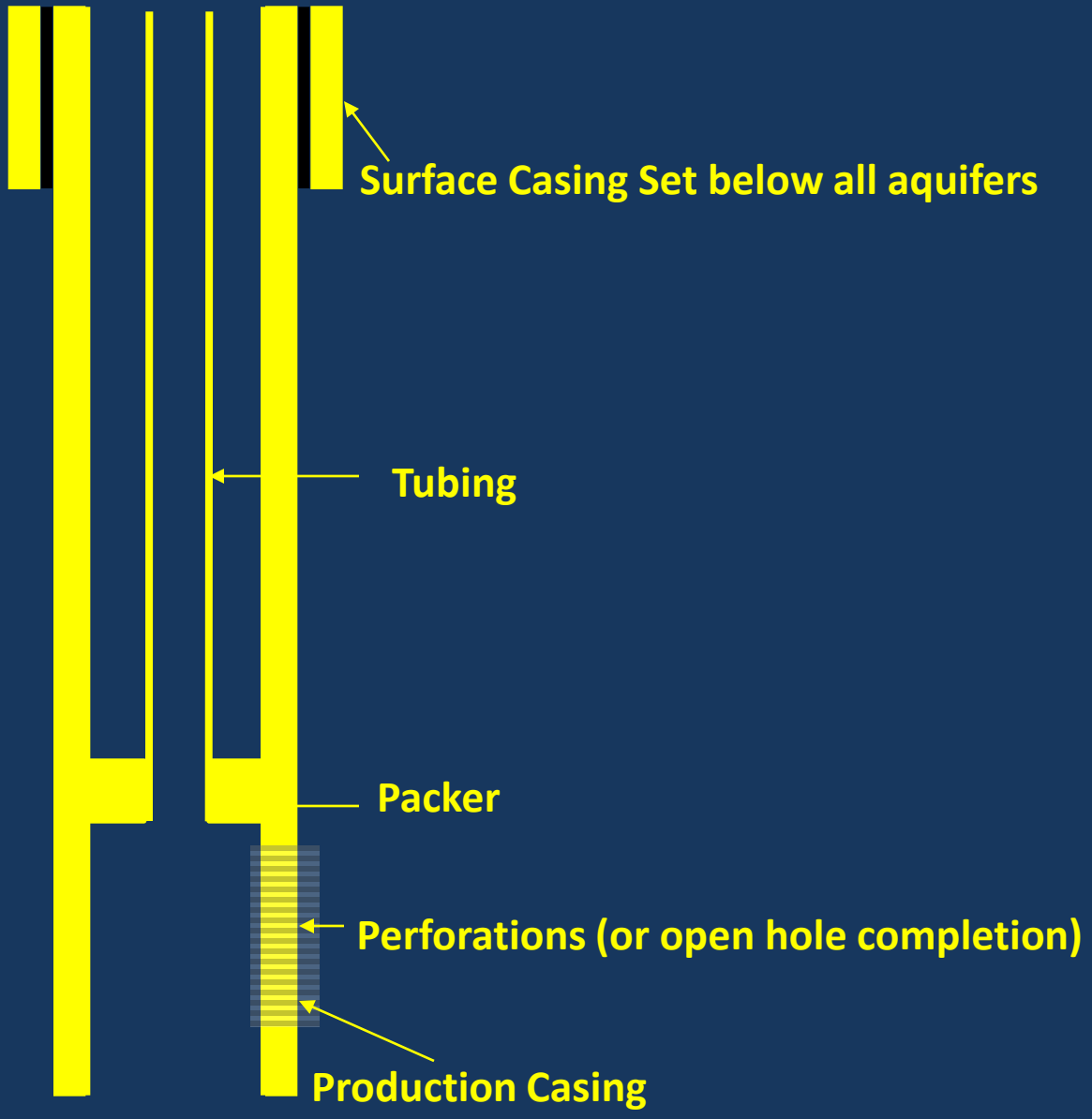
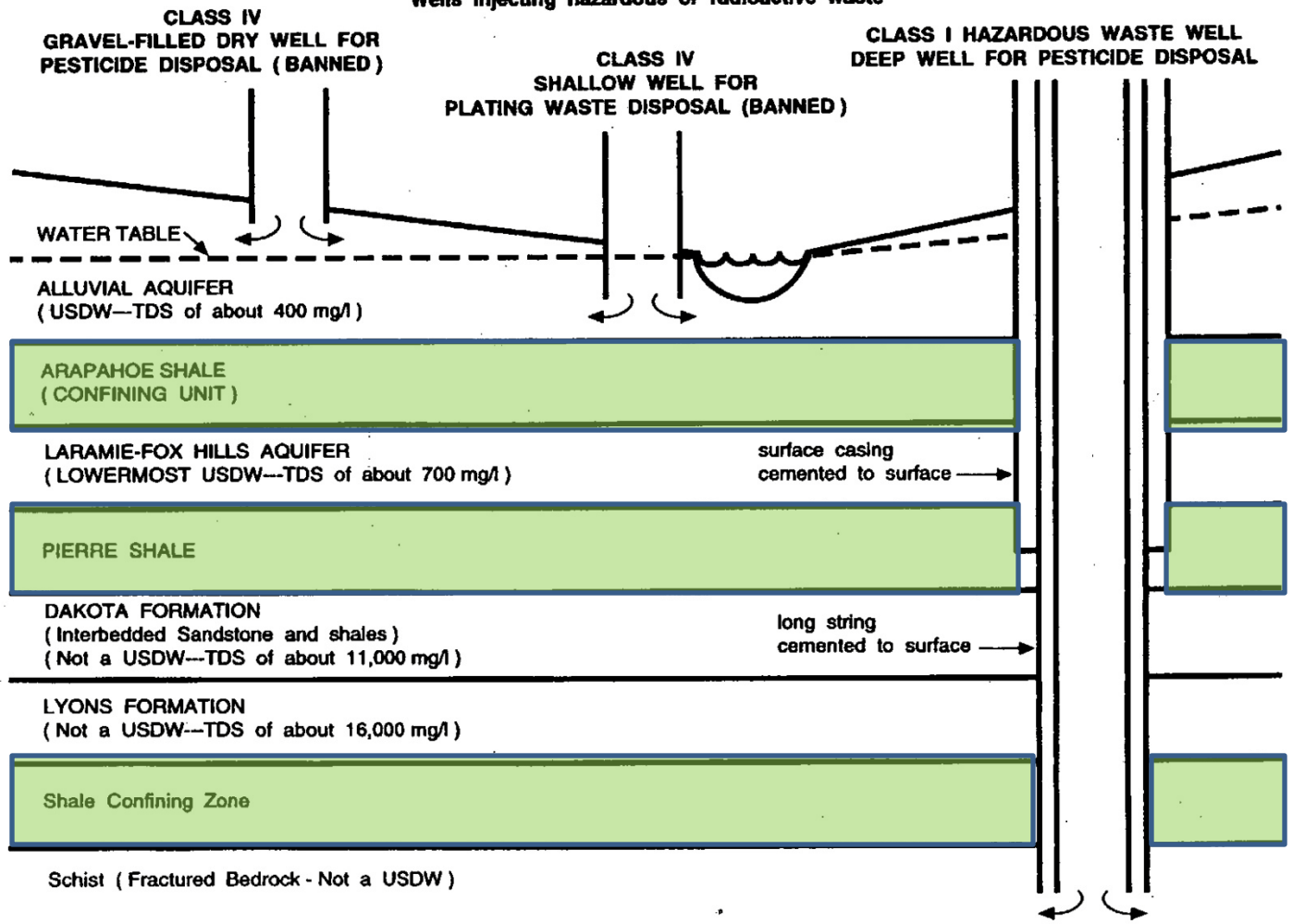
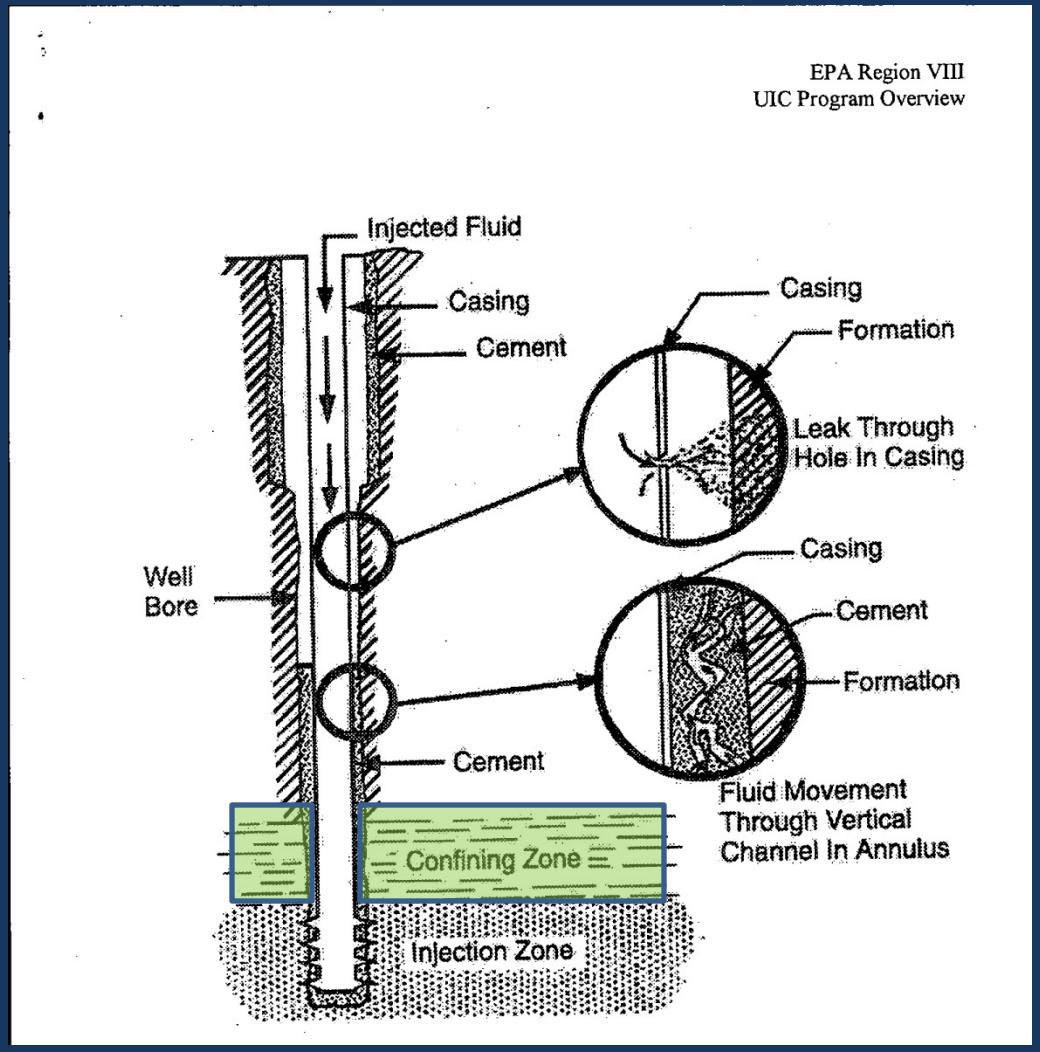


Figure 1
Wells injecting hazardous or radioactive waste





Checked by MIT

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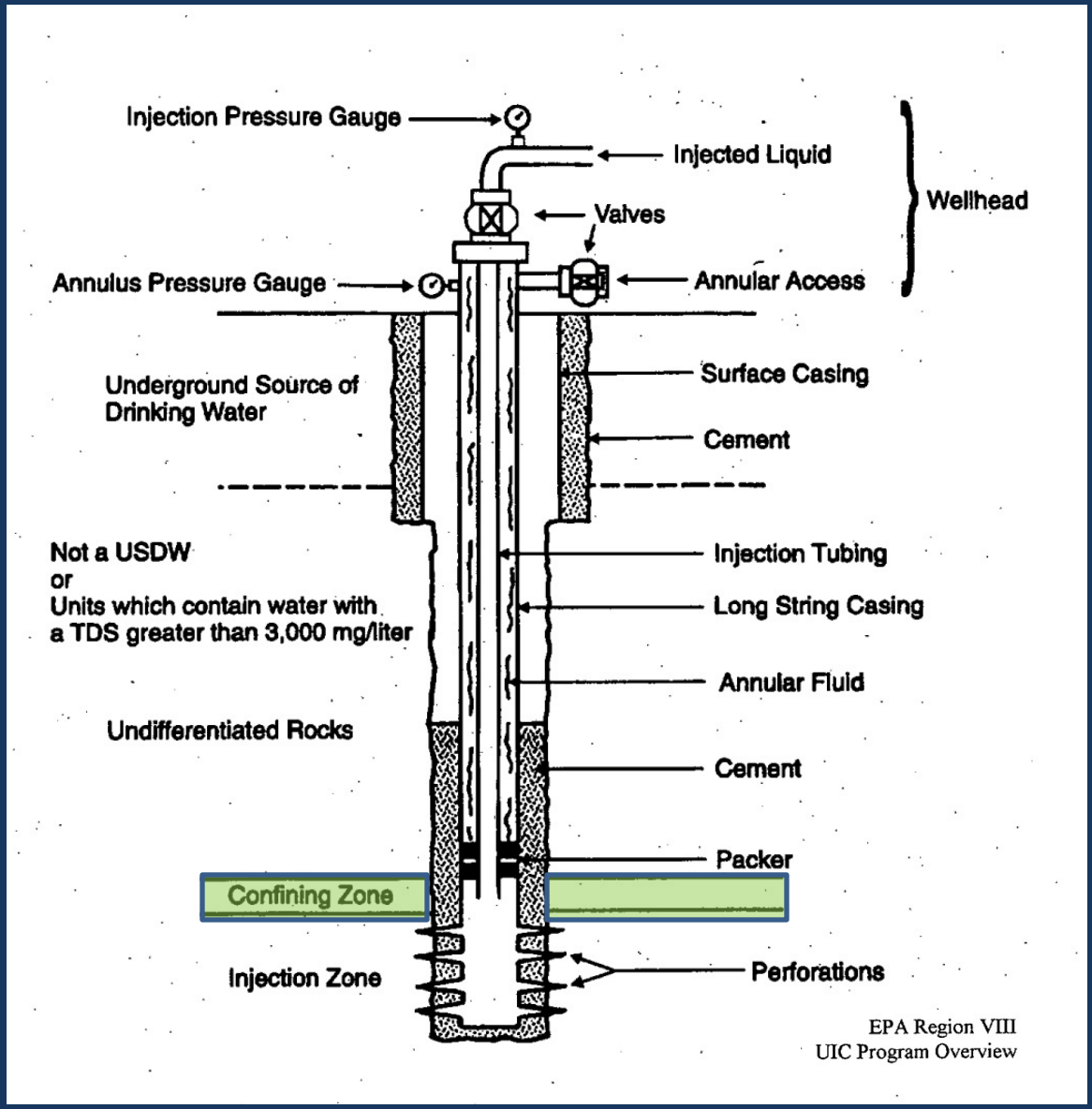
Injection Pressure Gauge
Injected Liquid
Valves
Wellhead
Annulus Pressure Gauge
Annular Access
Underground Source of Drinking Water
Surface Casing
Cement
Not a USDW
or
Units which contain water with a TDS greater than 3,000 mg/liter
Injection Tubing
Long String Casing
Annular Fluid
Undifferentiated Rocks
Cement
Packer
Confining Zone
Injection Zone
Perforations
EPA Region VIII
UIC Program Overview

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UIC Application Process (Rule 325)

- COGCC Rule 325 outlines the application process for underground injection.
- Injection Permit Application: Form 31 – contains details of the type of injection, fluid type, geology formation, injection rate and pressure.
- Injection Well Permit Application : Form 33 – describes the downhole geometry and perforations.
- Source of Produced Water for Disposal: Form 26 – provides a list of where the E&P waste is sourced.

Forms to Submit

- Form 2 – Permit to Drill (submitted online)
- Form 2A – Oil and Gas Location Assessment (submitted online)
- Form 4 – Sundry Notice
- Form 31 – Injection Permit Application
- Form 33 – Injection Well Permit Application
- Form 26 – Source of Produced Water

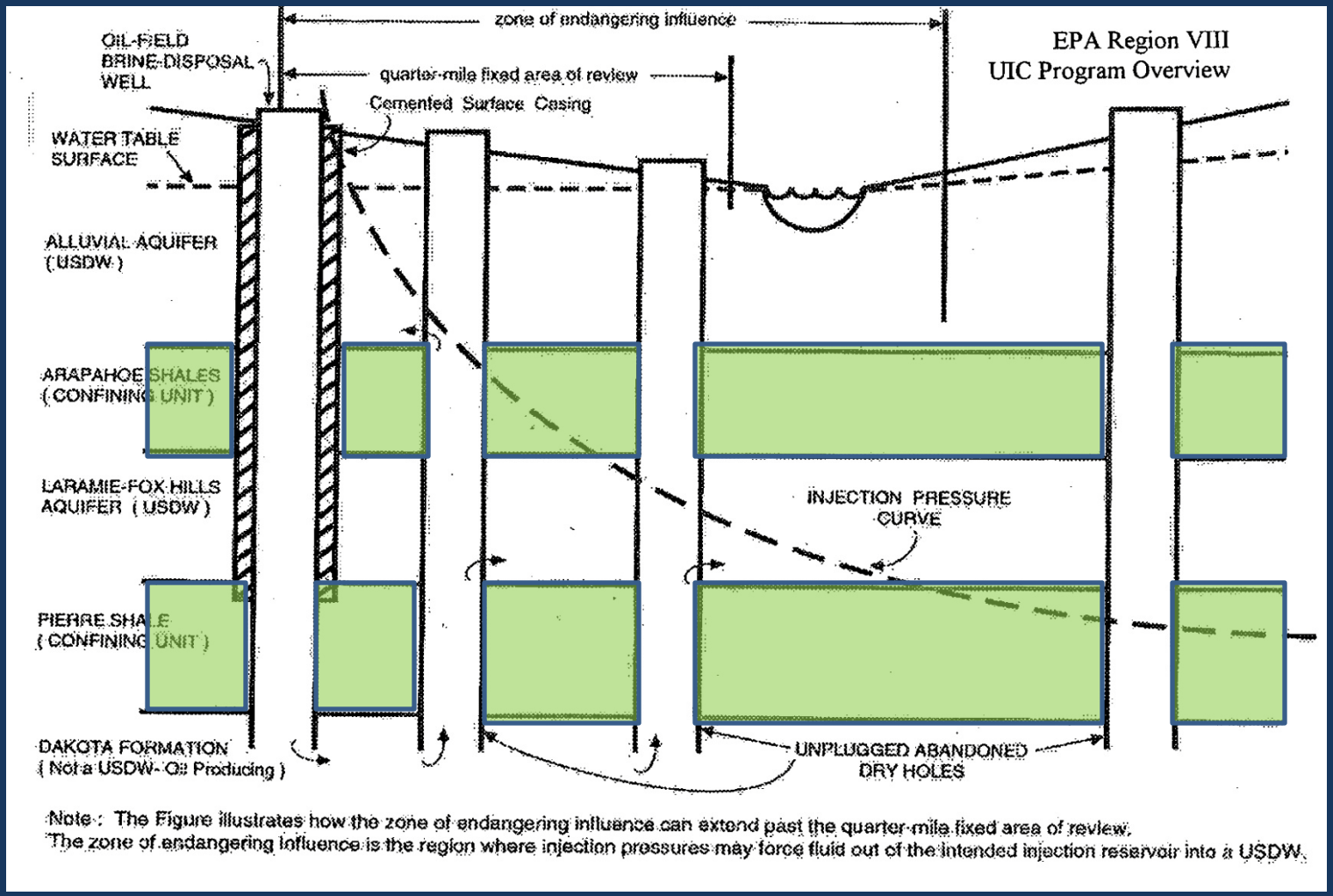
Forms to Submit

- Form 21 – Mechanical Integrity Test
- Form 42 – Notice of Notification (Notice of Hydraulic Fracturing)
- Form 5 – Drilling Completion Report (submitted online)
- Form 5A – Completed Interval Report (submitted online)

Form 31 Support Information

- Proposed injection program
- Surface owner agreement must specify salt water disposal or BLM sundry
- Notice to surface and mineral owners – a letter sent certified or registered mail or hand delivered to all surface and mineral owners within a ¼-mile area of review
- Remedial correction plan for wells – all wells within the ¼-mile area of review must have cement coverage to prevent water migrating vertically to another zone

Remedial Plans for Adjacent Wells



Form 31 Support Information (cont.)

- Maps and lists
  - Map of all wells (oil and gas and water) within ¼ mile of injection well
  - Map of all producing wells within ½ mile of injection well
  - Maps and lists of all surface and mineral owners within ¼ mile of injection well
  - Unit area plat (required for enhanced recovery)
- Surface facility plan view
- If commercial facility, description of operations and area served

Form 31 Support Information (cont.)

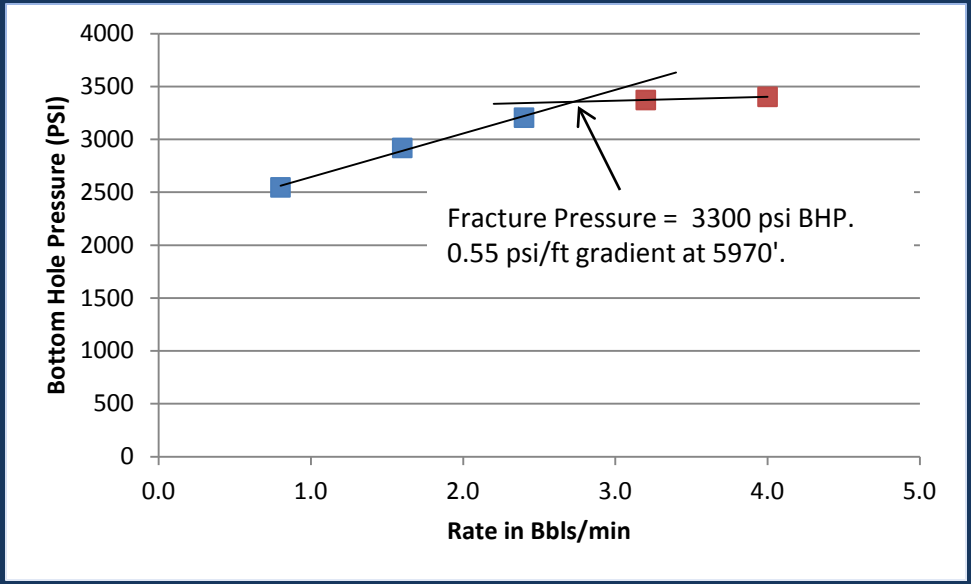
- Resistivity or induction log
- Cement bond log (can be uploaded with Form 5)
- Water analysis for injection zone (total dissolved solids) – must be from intended injection well or nearby well (same section) and same injection formation
- Contact person should be who to call with questions about well completion who is best able to answer questions – not necessarily the consultant who prepared the application

Step rate tests

- A step rate test may be performed by the operator to determine the fracture gradient of the injection formation.
- Step rate tests must be performed on new wells, once injection has begun the pore pressure increases and makes this data invalid.
- Default fracture gradient is 0.6 psi/ft.

Step rate tests (cont.)

- Submit data to COGCC for analysis
  - Data logger data is not necessary
  - Submit pairs of flow rate vs. pressure reading
  - Indicate if pressures are bottom hole or surface

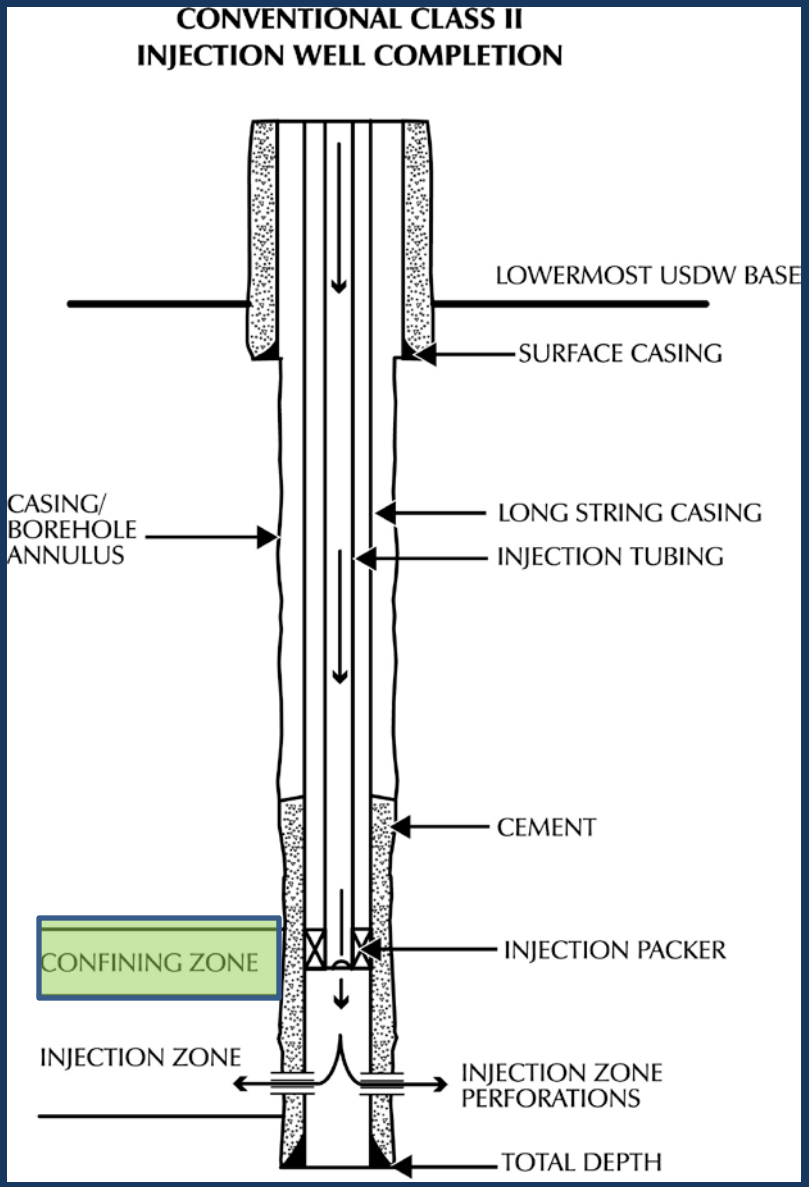


Injection Rate BPM	Surface Pressure PSI	Hydrostatic Pressure PSI	Friction Loss PSI	Calculated BHP PSI
0.8	0	2587	41	2546
1.6	420	2587	88	2919
2.4	800	2587	182	3205
3.2	1090	2587	305	3372
4	1320	2587	505	3402

Allowable injection pressure = (0.55 psi/ft – 0.433 psi/ft) x 5,970’ = 716 psi surface injection pressure

Form 33 Support Information

- Current wellbore diagram
- Proposed wellbore diagram
- Injection must take place at least 2000 feet below ground



Form 26 Support Information

- Source wells producing water to be injected
- Chemical analysis of fluids
- If more than six source wells, attach a table

UIC Application Process

Pre-drilling

- Forms 31, 33, 26, and, if applicable, Forms 2, 2A, and 4 are submitted at once – Forms 2 and 2A are submitted online
- Missing attachments to Forms 31, 33, and 26 may be added later if not immediately available
- Public notice will be posted once surface use agreement or BLM sundry as well as water analysis are received
- Memos are sent by COGCC to the Colorado Division of Water Resources and the Colorado Geological Survey for evaluation of groundwater protection and seismic activity, respectively

UIC Application Process

Post drilling

- Well is completed or re-completed by operator and Forms 5 and 5A submitted online, if applicable
- MIT is performed
  - Witnessed by state inspector
  - Submit Form 42, have 2 copies of Form 21 filled out for inspector's signature
  - Test must be performed to maximum requested injection pressure
- Maximum injection volume is calculated using neutron density and density porosity logs and geometry of ¼ mile radius cylinder of sandstone injection formation

Tricks to Make Things Faster!

- Contact the county government early – some have lengthy processes
- Do not start your project without including a geologist on your team
- Fill well 24 hours before MIT– this allows equilibrium of temperature and eliminates false pressure fluctuations
- Address all correspondence concerning injection wells to Denise Onyskiw

Approval Letter

- All approved injection permits have:
  - A maximum allowable injection pressure. This pressure is set to be below formation fracturing pressure.
  - A maximum allowable injection volume
  - Monitoring and reporting of amount of water injected and samples of water injected with a Form 4
  - Casing and cementing to prevent movement of fluid into or between USDWs. We sometimes require that special logs be run periodically.

UIC Inspections

- All UIC wells are inspected yearly
  - Injection pressure is checked
  - Annular pressure is checked
- All UIC wells are pressure tested for casing integrity every five years. Mechanical integrity failures must be shut-in.
- All UIC wells are equipped with a packer and tubing and the tubing casing annulus is inspected for leaks. Packer must be set within 100 ft of top perf.
- Any well showing abnormal pressure on the tubing annulus is required to cease injection and be repaired or plugged within six months.

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Seismic Issues

- Are there known Neogene (< 25 mya) faults in the area?
- Are there linear elements in the topography suggesting possible faults that are unmapped?
- Have any historic earthquakes been recorded in the area?
- Seismic monitoring might be prudent if earthquake triggering is deemed possible.
- Mitigation strategies might be considered prior to injection.

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Division of Water Resources Hydrologic Consultation

Hydrogeological Services

Matt Sares – Manager

Ralf Topper- Senior Hydrogeologist

Elizabeth Pottorff - Hydrogeologist

What we look at:

- Surface casing depth
- Other casing depths
- Principal sources of fresh ground water
- Registered water wells within ½ mile
- Distance to surface water or ditch
- Depth and formation of injection interval
- Intervening formation lithology
- Outcrop of injection formation

Produced Water Rules

- For Oil & Gas wells most formations and locations were determined as tributary or non-tributary to surface water
- No direct relationship to UIC approval
- Nontributary formation and area is better
- Glover model is also the standard to determine if an injection well would impact surface water

Our Recommendations

- “Based on the information provided, it does not appear that there is any potential for injury to known or potential sources of fresh water in the area from a properly constructed injection well.”
- Plug the borehole back to the base of the injection interval.
- “A plan to prevent runoff of surface spills would protect surface water.”

CDWR Public Information

- http://water.state.co.us/
- Data & Maps
  - AquaMap
  - Imaged Documents
- http://cdss.state.co.us/onlineTools/Pages/AquiferDeterminationTools.aspx
  - Denver Basin Aquifer Evaluation Tool

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Operator's timeline

- Geologic Analysis
  - Formation Adequacy
  - Seismicity Potential /Faulting
- Wellbore Integrity
  - Proposed Well
  - Surrounding Wells
- Federal/Local Permitting

Operator's timeline

- Injection Test
  - Prepare Injection Test Procedure
  - Submit Form 4 Sundry
- Notice of Application
  - Certified Mailings
    - surface owners within ¼ mile of the well
    - owners/operators of o&g wells producing from the formation within ½ mile of the well

Operator's timeline

- Form 31
  - Formation Details
    - TDS
    - Frac Gradient
    - Porosity
    - Permeability
    - Proposed Stimulation Program

Injection Fluid Type: ☑ Produced Water ☐ Natural Gas ☐ CO_2 ☐ Drilling Fluids ☐ Exempt Gas Plant Waste ☐ Used Workover Fluids ☐ Other Fluids (describe):

Commercial Facility? ☐ Yes ☑ No

If Yes, describe area of operation and types of fluids to be injected at this facility:

PROPOSED INJECTION FORMATIONS

FORMATION A (Name): WMFK Porosity: 16%

Formation TDS: 18000 ppm Frac Gradient: .64 psi/ft Permeability: 0.4 mD

Proposed Stimulation Program: ☐ Acid ☐ Frac Treatment ☑ None

FORMATION B (Name): n/a Porosity: n/a

Formation TDS: n/a Frac Gradient: n/a psi/ft Permeability: n/a

Proposed Stimulation Program: ☐ Acid ☐ Frac Treatment ☐ None

Anticipated Project Operating Conditions

Under normal operating conditions, estimated fluid injection rates and pressures:

FOR WATER: A minimum of 0 bbls/day @ 0 psi to a maximum of 3600 bbls/day @ 822 psi.

FOR GAS: A minimum of mcf/day @ psi to a maximum of bbls/day @ psi.

Complete the Attachment Checklist

	Oper	OGCC
Form 31 Original & 1 Copy	✓	
Analysis fo Injection Zone Water	✓	
Analysis of Injection Water	✓	
Proposed Injection Program	✓	
Resistivity or Induction Log	✓	
Cement Bond Log	✓	
Surface or Salt Water Displ Agrmt	✓	
Notice to Surface/Mineral Owners	✓	
Remedial Correction Plan for Wells		
Map Oil/Water Wells w/in 1/4 Mile	✓	
List Oil/Gas Wells w/in 1/2 Mile	✓	
Map Surface Owners w/in 1/4 Mile	✓	
List Surface Owners w/in 1/4 Mile	✓	
Map Mineral Owners w/in 1/4 Mile	✓	
List Mineral Owners w/in 1/4 Mile	✓	
Surface Facility Diagram	✓	
Wellbore Diagram	✓	
If Commercial Facility, Description of Ops & Area Served		
Unit Area Plat		

Operator’s timeline

- Form 33
  - Current Wellbore Information
  - Plug, Tubing and Packer Depths
  - Formation Perfs
  - Squeeze Work Details
  - Current Wellbore Diagram
  - Proposed Wellbore Diagram

Operator's timeline

- Form 26
  - List all potential sources of produced water
  - Representative Analysis
- Submittal
  - Form 31, 33 and 26 submitted concurrently
  - Digital Submittal Preferred

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Hydrofracturing with Diesel

- The Energy Policy Act of 2005 exempted hydrofracturing (as well as gas storage) from the UIC regulations unless diesel fuel is used as the hydrofracturing material.
- Thus, owners or operators who inject diesel fuels during HF related to oil, gas, or geothermal operations must obtain a UIC permit before injection begins.

EPA Definition of “Diesel”

- Any portion of the injectate has one of six listed CASRNs:
  - 68334-30-5
  - 68476-34-6
  - 68479-30-2
  - 68476-31-3
  - 8008-20-6
  - 68410-00-4
- Or, is referred to as “diesel fuel” in its primary name or common synonyms.

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